


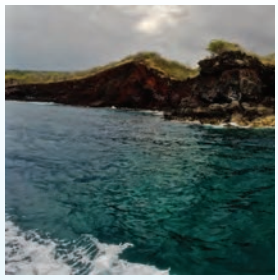


# Symposium on West Hawaii's Marine Ecosystem:

## Bridging the Gap Between Science and Management

**December 5–6, 2017**

JOINT INSTITUTE FOR MARINE AND ATMOSPHERIC RESEARCH
JIMAR
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NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NOAA
U.S. DEPARTMENT OF COMMERCE

IEA
INTEGRATED ECOSYSTEM ASSESSMENT

# Symposium on West Hawaii's Marine Ecosystem:
## Bridging the Gap Between Science and Management
## AGENDA – December 5, 2017

| Time | Name | Title |
|---|---|---|
| 8:15 – 9:00 | | **Registration** |
| 9:00 | Jamison Gove | Welcome and Introductory Remarks |
| 9:10 | Michael Seki | Implementing Ecosystem-Based Management: A Conceptual Framework for Providing Science Advice |
| 9:30 | Bruce Anderson | Aquatic Resource Management Planning at DAR |
| 9:40 | Anne Chung | Introduction to 30 by 30: Developing a Statewide Marine Management Plan to Effectively Manage 30% of Nearshore Waters by 2030 |
| 10:00 | William Walsh | Controversy, Conflict & Conservation – The Effectiveness of an MPA Network in Sustainably Managing the West Hawai'i Aquarium Fishery |
| 10:15 | Mary Donovan | Hawai'i Monitoring and Reporting Collaborative (HIMARC), Science to Support Effectively Managing Hawaii's Nearshore Marine Resources |
| 10:30 | Kaylyn McCoy | Estimating Nearshore Fisheries Production from the Main Hawaiian Islands Using Commercial and Non-Commercial Sectors |
| 10:45 | | **Break** |
| 11:00 | Sheila McKenna | Coral Reefs of Kaloko-Honok□hau National Historical Park in Hawai'i: Before, During, and After the 2015 Coral Bleaching Event. |
| 11:15 | Lindsey Kramer | Are coral reefs recovering in West Hawai'i? Benthic Status and Trends at Long-Term Monitoring Sites. |
| 11:30 | Ross Martin | Recruitment Dynamics of Scleractinian Corals along the Kona Coast of the Big Island of Hawai'i |
| 11:45 | Greg Asner | High-Resolution Mapping of Coral and Algal Cover Along Big Island Reefs |
| 12:00 | Joey Lecky | Mapping Anthropogenic Stress over Time and Space for the Nearshore Environment in West Hawai'i |
| 12:15 | | **Lunch** |
| 1:30 | Rusty Brainard | Defining Drivers of Exposure and Sensitivity of Unprecedented Mass Coral Bleaching in the Main Hawaiian Islands |
| 1:45 | Jamison Gove | Assessing Natural Versus Human Drivers of Coral Reef Communities in West Hawai'i |
| 2:00 | Eric Conklin | Relative Resilience of Coral Reefs in the West Hawai'i Habitat Focus Area: Recent Bleaching Impacts and Potential Management Actions |
| 2:15 | Jeffrey Polovina | West Hawai'i Sea Surface Temperature Dynamics – Past, Future, and Relevance to Reefs |
| 2:30 | Jeffrey Maynard | Climate Change Vulnerability Assessments for Marine and Coastal Habitats in West Hawai'i |
| 2:45 | Chad Wiggens | Sea Level Rise as a Catalyst for Coastal Conservation Action in West Hawai'i. |
| 3:00 | | **Break** |
| 3:15 | Mariska Weijerman | Evaluating Management Strategies to Optimize Ecosystem Services Provided by Coral Reefs |
| 3:30 | Mark Hixon | Coral Resilience Module Experiment (CReME): Enhancing Herbivores to Protect Corals |
| 3:45 | Donald Kobayashi | Extreme Dispersal Events: How El Niño Events Affect Reef Fish Population Connectivity in the West Hawai'i Region |
| 4:00 | Anna Neuheimer | Life History Strategies Shape Larval Reef Fish Settlement Success Off West Hawai'i Island |
| 4:15 | Short Film | Scientific Seas Presents: Science of Slicks |
| 4:25 | Jonathan Whitney | Surface Slicks as Important Nursery Habitat for Larval Fish in West Hawai'i |
| 4:40 | Katharine Smith | Physical Drivers of West Hawaii's Surface Slicks and Their Effects on Larval Fish |
| 5:00 – 6:30 | Information Booth Session | Meet local organizations making positive contributions to science, conservation and management related to the marine ecosystem in West Hawai'i |

# Symposium on West Hawaii's Marine Ecosystem:
## Bridging the Gap Between Science and Management
## AGENDA – December 6, 2017

| Time | Name | Title |
|---|---|---|
| 8:15 - 9:00 | | **Registration** |
| 9:00 | Fiona Langenberger | Coastal and Ocean Observations and Forecasts to Support Place-based Science and Management |
| 9:15 | Steven Colbert | Pelekane Bay Water Quality Buoy: A New Resource for Coastal Ocean Management |
| 9:30 | Kim Falinski | Linking Wastewater and Fertilizer Inputs to Coral Reef Health: Integrating Monitoring and Modeling Approaches for Conservation Planning |
| 9:45 | Jazmine Panelo | Spatial Distribution and Sources of Land-Based Dissolved Inorganic Nutrients at Coral Reefs in South Kohala |
| 10:00 | Devon Aguiar | Sewage Pollution Source Tracking on South Kohala Reefs |
| 10:15 | Tracey Wiegner | Identifying Locations of Sewage Pollution within Puako's Watershed and Comparison of On-Site Sewage Disposal Systems for Management Actions |
| 10:30 | | **Break** |
| 10:45 | Shannon Ruseborn | West Hawai'i Habitat Focus Area Partnership: Science, Restoration, Conservation and Community Action |
| 11:00 | Mary Donovan | Working Together to Understand, Quantify and Manage for Tipping Points on the Reefs of Hawai'i |
| 11:15 | Eva Schemmel | An Ocean Health Index for West Hawai'i |
| 11:30 | Arielle Levine | Monitoring Human Behavior and Perceptions in Hawai'i Through NOAA's National Coral Reef Monitoring Program (NCRMP) |
| 11:45 | Mia Iwane | Exploring Oceanic Whitetip Shark Interactions in Hawaii's Small-Scale Fisheries Through Fisher Engagement |
| 12:00 | Rebecca Ingram | Revealing Complex Social-Ecological Interactions Through Participatory Modeling in Hawai'i |
| 12:15 | | **Lunch** Interactive Session: Working together to represent communities within the West Hawai'i IEA |
| 1:45 | Melanie Hutchinson | Movement Behavior and Habitat Use of Pelagic Predators in the Waters Surrounding West Hawai'i |
| 2:00 | Jeffrey Drazen | Persistent and Dense Concentrations of Micronekton Along the Kona Coastline: A Potential Food Resource for Marine Mammals and Pelagic Fishes |
| 2:15 | Zach Caldwell | An Assessment of Mesophotic Reefs in Hawai'i as Fishing and Climate Change Refugia |
| 2:30 | Frank Parrish | In-situ Measurements of Environmental Variables at Keahole and other Hawaiian Deep Sea Coral Beds |
| 2:45 | Keolohilani Lopes | Effects of Open Circuit SCUBA Exhaust on Reef Fish Surveys |
| 3:00 | | **Break** |
| 3:15 | Syd Kraul | Reef Fish Aquaculture in Kona |
| 3:30 | Bill Coney | Rebuilding Our Coral Reefs One Polyp at a Time |
| 3:45 | Julien Stevens | Marine Aquaculture Opportunities in West Hawai'i |
| 4:00 | Rebecca Most & Ku'ulei Keakealani | Revitalization of the Fishpond of Kiholo |
| 4:30 | Jamison Gove | Closing Remarks |

# Symposium on West Hawaii's Marine Ecosystem: Bridging the Gap Between Science and Management

## Presentation Abstracts

## 5 December 2017

**5 December, 9:10 AM**

**Implementing Ecosystem-Based Management: A Conceptual Framework for Providing Science Advice**

**Michael Seki, PhD.**

NOAA's Pacific Islands Fisheries Science Center, Honolulu, Hawai'i

In his role as Science and Research Director of the Pacific Islands Fisheries Science Center, Dr. Seki provides the science direction and oversight of research activities that support stewardship of living marine resources in the vast expanse of the Pacific Islands Region. Since joining NOAA Fisheries in 1980, Dr. Seki has conducted extensive fisheries, oceanographic, and ecosystem research on many marine species in the Pacific region. He has authored or co-authored over 40 scientific papers and has participated on over 20 domestic and international research surveys, serving as the Chief Scientist on 14 of them. Prior to becoming Director, Dr. Seki served as Deputy Director for the Pacific Islands Fisheries Science Center; a position he had held since the Science Center was established in April 2003. In that position, he had the overarching responsibility and oversight of all Science Center operations. Dr. Seki is also the current team lead for NOAA Regional Collaboration efforts in the Pacific Islands Region.

Born and raised in Hawai'i, Dr. Seki received his B.S. in biology from the University of Oregon (Eugene), his M.S. in oceanography from the University of Hawai'i (Manoa), and his Ph.D. in marine environment and resources from Hokkaido University (Graduate School of Fisheries Science in Hakodate).

**5 December, 9:30 AM**

**Aquatic Resource Management Planning**

**Bruce Anderson, PhD.**

Hawai'i Division of Aquatic Resources, Honolulu, Hawai'i

Dr. Bruce Anderson is currently the Administrator for the State of Hawaii's Division of Aquatic Resources. Dr. Anderson has more than 20 years of experience in managing health, environmental protection and marine resource programs, policy and issues in Hawai'i. Dr. Anderson began his career as State Environmental Epidemiologist at the Hawai'i Department of Health focusing his research and interests on ciguatera fish poisoning and other aquatic marine toxins. As Deputy Director for Environmental Health for 12 years, he worked closely with the DAR staff in addressing problems associated with sewage spills and other pollution threats. When appointed by Governor Ben Cayetano as Director of the Department of Health, he served on the State Water Commission. As President of Oceanic Institute, he led a team of over 70 scientists, researchers and support staff in developing and transferring new aquaculture technologies to the private sector to produce shrimp, fish and other seafood in an environmentally sustainable manner. Most recently, he served as President and CEO of Hawai'i Health Systems Corporation.

Dr. Anderson was born and raised in Hawai`i. He attended Punahou School, Colorado College and received his Master's in Public Health from Yale University and a Ph.D. in biomedical sciences from the University of Hawai`i.

**5 December, 9:40 AM**

**Introduction to 30 by 30: Developing a Statewide Marine Management Plan to Effectively Manage 30% of Nearshore Waters by 2030**

**Anderson, B.**[1], A. Chung[2]

[1] Hawai‘i Division of Aquatic Resources, Honolulu, Hawai‘i
[2]University of Hawai‘i, Hawai‘i Coral Reef Initiative, Honolulu, Hawai‘i

In September 2016, Governor David Ige announced the Sustainable Hawai‘i Initiative at the IUCN World Conservation Congress. This initiative outlines specific sustainability targets, including a “30 by 30” marine target to “effectively manage 30% of nearshore ocean waters by 2030.” The objectives of this initiative are centered on supporting sustainable use of marine resources while also promoting the health and resilience of nearshore marine ecosystems, and include implementing statewide management actions, identifying key priority areas for management, encouraging responsible behavior through education and enforcement, and ensuring comprehensive marine monitoring efforts. The 30 by 30 Initiative will be led by the Division of Aquatic Resources (DAR), with opportunities for collaboration within the Department of Land and Natural Resources (DLNR) as well as other partners. An introduction to the 30 by 30 Initiative will be shared, highlighted by key messages from DAR Administrator Dr. Bruce Anderson.

**5 December, 10:00 AM**

**Controversy, Conflict & Conservation – The Effectiveness of an MPA Network in Sustainably Managing the West Hawai′i Aquarium Fishery**

**Walsh, WJ.[1]**, Jackson, LA.[1], Sanderlin, N.J.[1], Goecke, S.D.[2], Kramer, K.L.[2], Lamson Leatherman, M.R.[2], Martin, R.A.[2], Williams, I. D.[3]

[1]Hawaii Division of Aquatic Resources (DAR)
[2]Pacific Cooperative Studies Unit (PCSU) & DAR
[3]Ecosystem Sciences Division, Coral Reef Ecosystem Program, Pacific Islands Fisheries Science Center, Honolulu, Hawai‘i

The commercial collecting of marine organisms for the aquarium trade has been a controversial activity in West Hawai′i for over 30 years. In December 1999, a network of nine Fish Replenishment Areas (FRAs) was established in West Hawai´i to address declines of aquarium-collected reef fishes and associated user conflict. The FRAs, which prohibit aquarium collecting, were designated with substantial community input and together with already established protected areas, comprise 35.2% of the coastline. Further management actions have followed over the succeeding years culminating most recently (2013) in new rules limiting aquarium collecting to only 40 permitted fish species, size/bag limits on three heavily targeted species and the addition of a new FRA in South Kona. Coupled with an extensive ongoing monitoring program, the West Hawai′i aquarium fishery is one of the most intensively managed and studied fisheries in Hawai′i. Nonetheless, in recent years distortion and misinformation, oftentimes deliberate and purposeful, have increased regarding the fishery and its impacts on West Hawai′i reef fish populations. Drawing on coral reef monitoring data and other relevant scientific information, this talk will attempt to address some of the mythology surrounding the aquarium fishery and provide a more reality-based view of aquarium collecting and the effectiveness of the FRA network.

**5 December, 10:15 AM**

## Hawai‘i Monitoring and Reporting Collaborative (HIMARC), Science to Support Effectively Managing Hawaii’s Nearshore Marine Resources

**Donovan, M.K.**[1]

[1]Hawai‘i Institute of Marine Biology, University of Hawai‘i at Mānoa, Honolulu, Hawai‘i

There is a pressing need to better synthesize and utilize the tremendous body of available information on the status and trends of Hawaii’s nearshore resources. For example, scientific products for measuring ecosystem health are needed to meet the Sustainable Hawai‘i Initiative ocean commitment to “Effectively manage 30% of nearshore ocean waters by 2030”. Similarly, Hawai‘i resource managers are currently attempting to best respond to widespread and severe coral bleaching and mortality in recent years. Well-crafted products based on existing data can contribute enormously to prioritize areas most likely to benefit from management, and identify suitable management levers – i.e. specific targets for managers to effect needed changes. An important component of this is to synthesize and analyze survey data to generate ecosystem indicators that will provide accurate and meaningful measures of progress towards achieving management goals. To this end, the Hawai‘i Monitoring and Reporting Collaborative (HIMARC) has been formed to serve as a council of scientists who are principally involved in marine science and monitoring of Hawaii’s nearshore waters. Each of these organizations conducts marine monitoring around Hawai‘i, making Hawaii’s reefs some of the best studied in the world. The programs operate at a number of scales, and together provide a complementary story of Hawaii’s reef status and trends. I will present on the current and future activities and products from HIMARC, with specific discussion of how each is informing management of Kona’s and Hawaii’s marine resources.

**5 December, 10:30 AM**

## Estimating Nearshore Fisheries Production from the Main Hawaiian Islands Using Commercial and Non-Commercial Sectors

**McCoy, K.S.**[1,2,3], Williams, I.D.[3], Friedlander, A.[2,4], Ma, H.[5], Teneva, L.[6], Kittinger, J.N.[6,7]

[1]Joint Institute of Marine and Atmospheric Research, University of Hawai‘i at Mānoa, Honolulu, Hawai‘i
[2]Fisheries Ecology Research Lab, University of Hawai‘i at Mānoa, Honolulu, Hawai‘i
[3]Ecosystem Sciences Division, Coral Reef Ecosystem Program, Pacific Islands Fisheries Science Center, Honolulu, Hawai‘i
[4]Pristine Seas, National Geographic Society, Washington, DC
[5]Fisheries Research and Monitoring Division, Insular Fisheries Monitoring Program, Pacific Islands Fisheries Science Center, Honolulu, Hawai‘i
[6]Conservation International, Center for Oceans, Honolulu, Hawai‘i
[7]Arizona State University, Center for Biodiversity Outcomes, Julie Ann Wrigley Global Institute of Sustainability, Life Sciences Center, Tempe, Arizona

Nearshore reef-associated fisheries have great economic, recreational, and cultural value. Currently, information on these fisheries is frequently disparate or incomplete, creating a challenge for effective management. This study utilized an existing non-commercial fishery dataset from Hawai‘i, covering the period 2004-13, to estimate a variety of fundamental fishery parameters, including participation, effort,

gear use, and CPUE. We then used those data to reconstruct total catches per island. Non-commercial fisheries in this case comprise recreational, subsistence, and cultural harvest, which may be exchanged, but are not sold. By combining those data with reported commercial catch data, we estimated annual catch of nearshore reef-associated fisheries in the main Hawaiian Islands over the study period to be 1,167,758 ± 43,059 kg year$^{-1}$ (mean ± standard error). Average annual commercial reef fish catch over the same time period - 184,911 kg year$^{-1}$ - was 16% of the total catch, but that proportion varied greatly among islands, ranging from 23% on Oahu to 5% on Molokai. Our results emphasize the importance of reef fishing in Hawai‘i for reasons beyond commerce, such as food security and cultural practice, and highlight the large differences in fishing practice across the Hawaiian Islands.

**5 December, 11:00 AM**

**Coral Reefs of Kaloko-Honokōhau National Historical Park in Hawai‘i: Before, During, and After the 2015 Coral Bleaching Event**

**McKenna, S.A.**[1], Beavers, S.C.[2], Carlson, K.M.[2], McCutcheon A.L.[1]

[1]National Park Service, Pacific Island Network, Hawai‘i National Park, Hawai‘i
[2]Kaloko-Honokōhau National Historical Park, Kailua-Kona, Hawai‘i

The longest and most widespread global coral bleaching event on record occurred from 2014-17. The coral reefs within the Kaloko-Honokōhau National Historical Park and at other West Hawai’i locations were most affected from August to November 2015. We report findings on the Park’s benthic community during this event and for four years preceding and two years following it. Since 2007, the National Park Service Pacific Island Inventory and Monitoring Network have monitored the Park’s marine resources on an annual basis including the collection of benthic photo quadrats along thirty; 25-m transects (15 fixed, 15 random/temporary). A standardized monitoring protocol utilizing image analyses is implemented to determine coral species richness (#/transect), benthic cover by substrate type (%), and incidence of bleaching and disease (frequency of occurrence). In 2015, image analyses were modified to determine the percentage of bleached corals and the prevalence of bleaching by species for the photo quadrats on the fixed transects (n=26 photo quadrats per transect with 50 random sampling points per photo quadrat or 19,450 total sampling points per transect). Photo quads taken along fixed transects before 2015 were analyzed *a posteriori* and included 2014 and years prior. In 2015, the percent of bleached corals was 76.9% (n = 4193 coral points sampled). Observed frequency of bleaching by coral species was *Pocillipora meandrina* (99.4%), *Porites lobata* (76.8%), *P. compressa* (75.1%) and *Montipora capitata* (68.8%). Prior to 2015, the percent bleached corals ranged from 0.1-0.3%, with *M. capitata* (12% in 2008) most frequently observed to bleach and no bleaching observed in *P. lobata*. In 2016 the observed frequency of bleached coral was *M. capitata* (20%), *P. compressa* (2.8%) and *P. lobata* (2.2%). Average coral species richness (#corals/transect) was halved from five species per transect for previous years sampled to 2.5 species per transect in 2016. Percent live coral cover ranged from 26.9% to 32.4% pre-2015 to 21.6% in 2015 and 12% in 2016. Analyses of the 2017 benthic monitoring is underway and will provide better understanding of the resiliency of the Park’s coral reefs and inform management actions.

**5 December, 11:15 AM**

**Are coral reefs recovering in West Hawai‘i? Benthic Status and Trends at Long-Term Monitoring Sites**

**Kramer, K. L.**[1,2], Cotton, S. P.[1,2], M. R. Lamson[1,2], and Walsh, W. J.[1]

[1]Department of Land and Natural Resources, Division of Aquatic Resources (DAR), Kailua-Kona, Hawai‘i [2]Pacific Cooperative Studies Unit (PCSU), University of Hawai‘i at Mānoa, Honolulu, Hawai‘i

West Hawai‘i’s coral reefs suffered catastrophic mortality following the most intensive warming and coral bleaching event on record for the state in 2015. Coral bleaching mortality was estimated at an average relative loss of 49.7% coral cover for mid-depth reefs, with mortality rates estimated at > 90% for formerly common coral species including, *Pocillopora meandrina* and *Porites evermanni*. Benthic cover was re-analyzed in spring 2017 using standardized image analyses at 24 long-term monitoring sites, and was compared to benthic status before and soon after the bleaching event. Recovery in coral assemblages were analyzed by species, and changes in coral and algal cover, coral recruitment substrate availability, and other major benthic components were analyzed by site and management zone. Ecological implications following this massive decline in coral cover, the potential for future coral reef recovery, and possible management strategies will be discussed.

**5 December, 11:30 AM**

**Recruitment Dynamics of Scleractinian Corals along the Kona Coast of the Big Island of Hawai‘i**

**Martin, R. A.**[1], Walsh W. J.[1]

[1]Hawai‘i State Department of Land and Natural Resources, Division of Aquatic Resources, Kailua-Kona, Hawai‘i

Maintenance of adequate levels of coral recruitment is vital to sustain coral reefs. Because early life stages are often more susceptible than adults to environmental stressors, data on settlement and recruitment can help predict potential effects of disturbance from, and resilience to, environmental change. The spatial-temporal variability of scleractinian coral recruitment is currently being investigated along the west coast of Hawai'i. Starting in April 2004 to the present, terra cotta coral settlement tiles have been placed at ten sites spanning the leeward side of Hawai'i Island.

Eight tiles at each of the nine sites are replaced biannually before and after known seasonal peaks in coral reproduction and recruitment. The tiles from each site are then processed for microscope analysis, and coral recruits are counted and identified to genus. A tenth site Acropora Gardens, was added in August 2013, because of the discovery of a species of coral (*Acropora gemmifera*) never described in the main Hawaiian Islands. With six rounds of data collected thus far, there has been only a single polyp that is significantly different from all the other Acroporidae found along the coast and at this site, suggesting it could be *A. gemmifera*. Ideally more will be found to help confirm this.

Several spatial and temporal trends are emerging in this ongoing study. The relative contribution of the different families of recruits (Poritidae: 53.4%, Acroporidae 26.7%, Pocilloporidae 12.7%) and recruitment rates (average of all sites: 28 recruits $m^{-2}/year^{-1}$) recorded along the Kona coast are low

compared to other areas around the state of Hawai'i. The two northern most sites, Waiaka'ilio and Puakō, have significantly higher densities of corals recruits, with much lower densities at all the sites to the south.

Approximately 60% of the time the coral recruits preferred to settle on the bottom outside edge of the tiles compared to the vertical edges (26.5%) and the top (5.4%). This is likely the result of intense competition with filamentous algae, grazing herbivorous fish and urchins, and/or particle scouring, which can occur on the exposed surfaces of the tiles. Peak settlement of coral larvae occurs 80.8% of the time during the summer months (approximately April - September) in species with and without planktonic larvae. These distinctive characteristics in recruitment patterns underline the important role of life history strategies in understanding the spatial-temporal patterns of coral populations. The comparably low coral recruitment rates noted in this study indicate that recovery from natural and/or anthropogenic influences will likely be slow.

**5 December, 11:45 AM**

**High-resolution Mapping of Coral and Algal Cover along Big Island Reefs**

**Asner, G**.

Department of Global Ecology, Carnegie Institution for Science

Coral reef ecosystems along the West Hawai‘i (Big Island) coast have undergone massive change in recent years during and following repeated hot water-bleaching events. However, the ecology and geography of coral loss, survival, and recovery remain highly uncertain in space and time, largely due to the practical limitations of field-based monitoring approaches. In response, we have developed a mapping approaching using airborne laser-guided imaging spectroscopy from the Carnegie Airborne Observatory (CAO; http://cao.carnegiescience.edu) that reveals the cover and extent of live and dead corals, and algal-covered benthic surfaces, at spatial resolutions of 0.4 to 1.0 meters. Our results show highly variable coral and algal cover in the 1-15 meter depth range along the West Hawai‘i coast, with patterns of loss, bleaching resistance, and recovery associated with embayments, offshore topography, and other factors. This talk will highlight some of the advances in airborne coral reef monitoring, as well as current challenges from both scientific and conservation viewpoints.

**5 December, 12:00 PM**

**Mapping anthropogenic stress over time and space for the nearshore environment of West Hawai‘i**

**Lecky, J**.[1,2], Gove, J. [2], Whittier, R.[3], McCoy, K.[1,2], Walsh, W.[4]

[1]NOAA, Pacific Islands Fisheries Science Center, Honolulu, Hawai‘i, USA
[2]Joint Institute for Marine and Atmospheric Research, University of Hawai‘i at Mānoa, Honolulu, Hawai‘i, USA
[3]Hawaii State Department of Health, Honolulu, HI, USA
[4]Hawaii Division of Aquatic Resources, Honolulu, HI, USA

A wide range of human activities have an impact on coral reefs and maps of the spatial distribution, intensity, and cumulative impact of these anthropogenic stressors are important tools to help elucidate the underlying drivers of reef degradation. In this research we compiled a suite of existing spatial data and

developed geospatial methodologies to produce a novel time series database of human activity and anthropogenic stressor spatial maps for West Hawai‘i, including: human population density, three types of fishing activity (commercial, non-commercial, and aquarium), and three measures of land based pollution (sewage from cesspools and injection wells, impervious surfaces, and golf courses). In this presentation we will show maps and temporal trends of anthropogenic stresses over recent decade or longer time periods. These maps will be useful for scientific and management planning as well as public outreach applications, and will be made publicly available. Effective management of local stressors can support reef resilience to impacts of climate change. Having accurate maps of the spatial distribution and intensity of local stressors and human activities is a critical component of deciding where and to what degree management actions are needed.

**5 December, 1:30 PM**

**Defining Drivers of Exposure and Sensitivity to Unprecedented Mass Coral Bleaching in the Main Hawaiian Islands**

**Oliver, T.**[1], Couch, C.S.[1,2], Ritson-Williams, R.[3], Meier, O.,[3] Hawai‘i Coral Bleaching Collaborative

[1]Ecosystem Sciences Division, Coral Reef Ecosystem Program, Pacific Islands Fisheries Science Center, Honolulu, Hawai‘i
[2]The Nature Conservancy Hawai‘i Program, Honolulu, Hawai‘i
[4]Hawai‘i Institute of Marine Biology, Kāne‘ohe, Hawai‘i

In 2014 and 2015 the Hawaiian Archipelago experienced unprecedented back-to-back mass coral bleaching events. Both events were associated with widespread and severe thermal stress linked to a combination of climate change, “the Blob”, and the Pacific Decadal Oscillation. However, the patterns of thermal stress varied considerably between years with more stress in the Northwestern Hawaiian Islands (NWHI) in 2014 and more stress (up to 18 consecutive weeks) in the Main Hawaiian Islands (MHI) in 2015. In June 2015, six organizations created the Hawai‘i Coral Bleaching Collaborative to combine datasets that address the extent and severity of these bleaching events, drivers of bleaching patterns, and long-term consequences on reef communities. Partners conducted >900 surveys during 2014 to 2015 over 1,025 km2. These collective data revealed that the NWHI were more affected in 2014, and the MHI more in 2015, with the severe 2015 MHI bleaching showing up to 90% of corals bleaching in certain regions. However, some sites had relatively low bleaching despite high thermal stress, suggesting that Hawai‘i may host some surprisingly resistant coral populations. This talk will focus on the environmental drivers of bleaching extent and mortality in the Main Hawaiian Islands, focusing both spatially from data collected statewide. Using this dataset, researchers are testing mechanisms of resilience and managers are developing strategies to minimize local stressors in areas most susceptible to thermal stress.

**5 December, 1:45 PM**

**Assessing Natural Versus Human Drivers of Coral Reef Communities in West Hawai‘i**

**Gove, J.**[1]**,** Lecky, J.[1,2], Walsh, W.[3], Kramer, L.[3], Williams, G.,[4] Maynard, J.[5]

[1]Ecosystem Sciences Division, Pacific Islands Fisheries Science Center, Honolulu, Hawai‘i
[2]Joint Institute of Marine and Atmospheric Research, University of Hawai‘i at Mānoa, Honolulu, Hawai‘i
[3]Hawaii Division of Aquatic Resources, Kona, Hawai‘i

[4]School of Ocean Sciences, Bangor University, UK
[5]SymbioSeas and the Marine Applied Research Center, Wilmington, NC

Coral reef ecosystems are exposed to a range of oceanographic drivers such as waves and temperature that are major determinants of reef ecosystem structure and function across space and through time. Simultaneously acting are a suite of human drivers, including coastal development, waste water pollution, and overfishing, which can fundamentally alter coral community organization and degrade ecosystem integrity. Disentangling natural versus human drivers of coral reef ecosystems is critical to the development of effective and sustainable management practices and for preserving the essential ecosystem services. In this research we combine high resolution modelled and remotely-sensed oceanographic information with novel human stressor data to investigate the underlying drivers of benthic coral reef communities in West Hawai‘i. Specifically, we focus on coral reef communities both before and after the 2015 bleaching event to assess the impacts of chronic and acute disturbances on reef ecosystem health.

**5 December, 2:00 PM**

**Relative resilience of coral reefs in the West Hawai'i Habitat Focus Area; recent bleaching impacts and potential management actions**

**Conklin, E.**[1]*, Maynard, J.[2,3]*, Minton, D.[1], Most, R.[1], Couch, C.[4], Williams, G.[5], Gove, J.[6], Tracey, D.[7], Schumacher, B.[8], Walsh, W.[9], Martinez, J.[10], Harper, D.[10], Jayewardene, D.[10], Parker, B.[11], Watson, L.[10]

[1]The Nature Conservancy Hawai‘i Program, Honolulu, Hawai‘i, USA
[2]SymbioSeas and the Marine Applied Research Center, Wilmington, NC, USA
[3]Laboratoire d'Excellence, CORAIL, USR 3278 CNRS-EPHE, CRIOBE, Papetoai, Polynésie Française
[4]Hawai‘i Institute of Marine Biology, Kāne‘ohe, Hawai‘i, USA
[5]School of Ocean Sciences, Bangor University, UK
[6]Ecosystem Sciences Division, Pacific Islands Fisheries Science Center, Honolulu, Hawai‘i, USA
[7]28 Dalziel Street, Stratford QLD 4870
[8]Coral Reef Ecosystem Program, Pacific Islands Fisheries Science Center, Honolulu, Hawai‘i, USA
[9]Hawai‘i Division of Aquatic Resources, Honokohau Marina, Kailua-Kona, Hawai‘i, USA
[10]Hawaiian Islands Humpback Whale National Marine Sanctuary, Honolulu, Hawai‘i, USA
[11]NOAA Coral Reef Conservation Program, Silver Spring, MD, USA

Coral reefs are of critical importance to the communities and environment of West Hawai'i, and supporting the resilience of reefs is a goal within many management plans in the area. Resilience-based management of coral reefs can include assessing spatial variation in resilience potential and then targeting and tailoring appropriate actions to preserve or restore resilience. In October 2015, our project team assessed the relative resilience and severity of bleaching impacts at 20 sites along the South Kohala and North Kona coastline, surveying deep and shallow reefs at each site. The team returned in 2016 to assess mortality due to bleaching, and developed lists of potential actions that would support reef resilience by combining resilience assessment results with information on stress related to human activities. An average ($\pm$1sd) of 68.41 $\pm$ 15.23% of shallow and 59.96 $\pm$ 17.66% of deep corals were partially or fully bleached in 2015. Sites in South Kohala had worse bleaching than those in North Kona. Coral loss between 2015 and 2016 was greatest where severe bleaching prevalence in 2015 was highest (South Kohala). In the shallow reef areas, coral cover decreased from 28% in 2015 to 20% in 2016. Average coral cover decline was 8%; with a 21% decline the largest observed. In the deep reef areas, coral cover decreased from 23% in 2015 to 16% in 2016. Average

coral cover decline was 6%, with a 37% decline the largest observed. For relative resilience, there was a general pattern for both depths that values for all resilience indicators were lower in northern South Kohala and higher in southern South Kohala. Most of the 20 survey sites met criteria we set for at least one potential management action that would support reef resilience, increasing the chances coral reefs in West Hawai‘i can cope with climate change.

**5 December, 2:15 PM**

**West Hawai‘i Sea Surface Temperature Dynamics – Past, Future, and Relevance to Reefs**

**Polovina, J. J.**[1] and Gove, J.M.[1]

[1]Pacific Islands Fisheries Science Center, NOAA Fisheries, Honolulu, Hawai‘i

Satellite remotely-sensed sea surface temperature (SST) for the West Hawai‘i coast shows seasonal, inter-annual, and decadal variation responding to both local and basin-scale forcing including influences from the El Nino and Southern Oscillation, the Pacific Decadal Oscillation, and the North Pacific Gyre Oscillation. Extreme SST in September 2015 was the highest in the 136-yr reconstructed record likely due to the coincidence of weak gyre circulation, very weak trade winds due to a strong positive PDO, an El Nino, and warming in the northeastern Pacific, plus reduced local cloud cover. A comparison between temperature loggers at 12 – 15 m depth in 13 reef locations along the coast shows 4 km satellite SST does a good job at capturing both the temporal dynamics and absolute temperature on the reefs during the 2015 event. Going forward a suite of climate models project under the business-as-usual scenario, a rising trend in SST resulting in annual sever bleaching for the reefs of West Hawai‘i beginning in about 2040.

**5 December, 2:30 PM**

**Climate Change Vulnerability Assessments for Marine and Coastal Habitats in West Hawai‘i**

**Maynard, J.**[1,2] and Gove, J.[3]

[1,2]SymbioSeas and the Marine Applied Research Center, Wilmington NC
[3]Ecosystem Sciences Division, Pacific Islands Fisheries Science Center, Honolulu, Hawai‘i

Reducing vulnerability to climate change requires assessing and understanding vulnerability drivers, as well as variation in vulnerability among habitats and species groups and across space. A team is being assembled to collaborate with the NOAA West Hawai‘i Integrated Ecosystem Assessment program and other partners to develop climate change vulnerability assessments (CCVA) for West Hawai‘i. Vulnerability assessments are planned for these marine and coastal ecosystem habitats and species groups: coral reef benthic and fish communities, pelagic and coastal pelagic fish, bottom fish, cetaceans, turtles, monk seals, anchialine pools, and fish ponds. We will synthesize available data on projected climate impacts (exposure) and indicators of sensitivity and adaptive capacity for each habitat and species group. A vulnerability metric will then be developed to quantify results so that, for example, forereef coral reef sites, can be systematically ranked based on their relative vulnerability to climate change. The final assessments will take the form of brochures, a report, and a website where the reporting products will be explained and available for download with all input data. This presentation will describe the project plan and timeline and the planned multiple opportunities for partners to engage in all parts of the CCVA process.

**5 December, 2:45 PM**

**Sea Level Rise as a Catalyst for Coastal Conservation Action in West Hawai‘i**

**Wiggins, C.**[1], Flessner, L.[2], Marra, J.[3], Marrack, L.[4], Conklin, E.[1], Harper, D.[5], Genz, A.[6], Most, R.[1], Ferdana, Z.[2], Falinski, K.[1]

[1]The Nature Conservancy of Hawai‘i, Honolulu, Hawai‘i
[2]The Nature Conservancy Global Oceans
[3]NOAA Pacific Region NESDIS/NCEI, Honolulu, Hawai‘i
[4]UC Berkeley, Department of Science, Policy, and Management, Monterey, CA
[5]The Baldwin Group under contract at NOAA NOS Office of Coastal Management, Honolulu, Hawai‘i
[6]The University of Hawai‘i, Hilo, Hawai‘i

In Hawai‘i, coastal groundwater-fed brackish pools provide habitat for unique native anchialine ecosystems, upon which multiple cultural traditions rely including the North Kona open ocean fishery for ‘ōpelu, *Decapterus macarellus*. As flooding frequency and intensity increase due to rising seas, these amazing ecosystems, as well as the threats that imperil them, will expand into new habitat, if low lying areas persist. Strategies such as active restoration, land protection, and infrastructure upgrades have potential to change the future ecological viability of anchialine habitat. To understand future scenarios, a team of climate scientists, biologists, GIS specialists, and technologists developed a decision-support tool to visualize the frequency and severity of likely flooding in North Kona-South Kohala, West Hawai‘i. Sea-level rise models were developed to incorporate the current location of priority ecosystems, high resolution LiDAR data, extreme water levels from local tide gauges, the influence of groundwater on flooding, and future SLR scenarios. The model outputs depict the future probability of habitat loss to ocean inundation, new habitat locations, and introduced species spread. An easy-to-use web mapping application available at maps.coastalresilience.org/Hawai‘i enables scientists, managers, planners, and others to visualize various flood scenarios, export maps and summary reports, and collaborate online. The goal of this tool is to provide scientifically defensible evidence to catalyze action to protect and restore precious coastal cultural ecosystems at risk. In early 2018, this tool will be used to update the South Kohala Conservation Action Plan to incorporate management recommendations based on future sea level projections.

**5 December, 3:15 PM**

**Evaluating Management Strategies to Optimize Ecosystem Services Provided by Coral Reefs**

**Weijerman, M.**[1,2], Gove, J.M.[2], Williams, I.D.[2], Walsh, W. J.[3], Minton, D.[4], Polovina, J.[2]

[1]Joint Institute of Marine and Atmospheric Research, University of Hawai‘i at Mānoa, Honolulu, Hawai‘i
[2]Ecosystem Sciences Division, Pacific Islands Fisheries Science Center, Honolulu, Hawai‘i
[3]Hawaii Division of Aquatic Resources (DAR)
[4]The Nature Conservancy of Hawai‘i, Honolulu, Hawai‘i

This study is a result of close cooperation between local coral reef managers, NGOs, and scientists to evaluate potential management approaches that can help in improving the current degraded state of corals reefs in the face of climate change. The governor of Hawai‘i has pledged to have 30% of the coast line 'effectively' managed by 2030 and this study shows potential ways to do this. We developed a customized ecosystem model to evaluate the performance of alternative management scenarios at Puakō in the

provisioning of ecosystem services to human users (marine tourists, recreational fishers) and enhancing the reef's ability to recover from pressures (resilience). Outcomes of the continuation of current management plus five alternative management scenarios were compared under both high and low coral-bleaching related mortality over a 15-year time span. Results suggest that current management is not adequate to prevent further declines in marine resources. Fishing effort is already above the multispecies sustainable yield, and, at its current level, will likely lead to a shift to algal-dominated reefs and greater abundance of undesirable fish species. Scenarios banning all gears other than line fishing, or prohibiting take of herbivorous fishes, were most effective at enhancing reef structure and resilience, dive tourism, and the recreational fishery. Allowing only line fishing generated the most balanced trade-off between stakeholders, with positive gains in both ecosystem resilience and dive tourism, while only moderately decreasing fishery value within the area.

**5 December, 3:30 PM**

**Coral Resilience Module Experiment (CreME): Enhancing Herbivores to Protect Corals**

**Hixon, M.**[1], Dilley, E.[1], Brush, E.[1], and Jones, R.[1]

[1]Department of Biology, University of Hawai‘i at Mānoa, Honolulu, Hawai‘i

Herbivores are crucial for the resilience of reef-building corals by keeping macroalgae in check, yet are terribly overfished on the main Hawaiian Islands, especially O‘ahu. One means of enhancing the local abundance of herbivorous fishes and urchins on degraded reefs is to deploy artificial coral heads that provide ample shelter and settlement surfaces. A pilot experiment on the south shore of O‘ahu is using cubic-meter concrete modules to cross-factor shelter availability (zero vs. many holes) with fishing intensity (low at Hanauma Bay vs. high off Waikiki). Results from the first year following deployment test five hypotheses regarding initial patterns of settlement: (1) Modules with many holes will be colonized by fishes and urchins more rapidly than those without holes: corroborated. (2) Because fish and urchin density is greater at Hanauma Bay, which likely produces more favorable settlement cues, modules there will be colonized by herbivores more rapidly there than off Waikiki: corroborated for urchins, falsified for fish. (3) Alternatively, because there is little natural shelter available off Waikiki, modules there will be colonized by herbivores more rapidly there than in Hanauma Bay: corroborated for fish, falsified for urchins. (4) Where herbivores are more abundant, algae will be less abundant: corroborated. (5) Where herbivores are more abundant, corals will be more abundant: falsified. Falsification of the last hypothesis reflects the fact that ample coral settlement occurred on all modules regardless of experimental treatment and initial patterns of benthic succession. Time will tell whether modules with few herbivores and much macroalgae will suffer high coral mortality due to algal-coral competition.

**5 December, 3:45 PM**

**Extreme Dispersal Events: How El Niño Events Affect Reef Fish Population Connectivity in the West Hawai‘i Region**

Wren, J.L.K.[1], Toonen, R.J.[2] , and **Kobayashi, D.R.[3]**

[1]Joint Institute for Marine and Atmospheric Research, University of Hawai‘i at Mānoa, Honolulu, Hawai‘i
[2]Hawai‘i Institute of Marine Biology, Kāne‘ohe, Hawai‘i

[3]Pacific Islands Fisheries Science Center, NOAA, Honolulu, Hawai‘i

As a result of climate change, stronger, more frequent El Niño events are predicted. These events in the Central Equatorial Pacific cause increased sea surface temperatures (SST), a depressed thermocline, and decreased primary production. The oceanographic effects in the Hawaiian Archipelago are not equally well understood, and have shown both increased and decreased SST and primary production. Larval development rates can be affected by food availability and temperature, thus oceanographic changes caused by El Niño can potentially alter larval dispersal patterns throughout the Hawaiian Archipelago, affecting regional population connectivity. Indeed, coral reef fish have shown increased recruitment in Hawai‘i during El Niño years, but the underlying drivers of that increase remain unknown. Using a two dimensional Lagrangian particle dispersal model coupled with high resolution currents for the West Hawai‘i Region we are able to model annual settlement probabilities and self-recruitment, important metrics for understanding population dynamics and connectivity. Preliminary data comparing dispersal probabilities during the 1997-98 El Niño with four years of normal state oceanographic conditions (2011-2014), showed an increase in total settlement during the El Niño years. Additionally, self-recruitment was lower during El Niño and the distance the successful settlers traveled was greater, indicating that El Niño years may be playing an important role in long distance dispersal and genetic exchange among islands not otherwise connected. Since these ecologically rare but extreme events can have a disproportionate influence on dispersal, it is important to understand how connectivity is affected in order to manage for diverse coral reefs in the future.

**5 December, 4:00 PM**

**Life history strategies shape larval reef fish settlement success off west Hawai‘i Island**

Wong-Ala, J.A.T.K.[1,2], Comfort, C.M.[1], Gove, J.M.[3], Hixon, M.A.[4], McManus, M.A.[1], Powell, B.S.[1], Whitney, J.L.[1,3,5], and **Neuheimer, A.B.**[1]

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[3]Pacific Islands Fisheries Science Center, National Oceanic and Atmospheric Administration (NOAA), Honolulu, Hawai‘i
[4]Department of Biology, University of Hawai‘i at Mānoa, Honolulu, Hawai‘i
[5]Joint Institute for Marine and Atmospheric Research, University of Hawai‘i at Mānoa, Honolulu, Hawai‘i

Larval settlement is shaped by the interaction of biological processes (e.g., life history timing) and the environment (e.g., temperature, currents etc.). This is particularly true for many reef fishes where larval stages disperse offshore, often spending weeks to months in the open ocean before settling to shallow-water reefs. Our ability to predict reef fish settlement and subsequent population productivity depends on our ability to explain how biological processes interact with the dynamic physical environment for these early life stages. Here we develop and apply an individual-based model that combines biological processes with high-resolution physical forcing to predict larval fish dispersal and settlement over time and space. Our model tracks individual larval fish from spawning to settlement and allows for the inclusion of biologically relevant stochasticity (individual variability) in modeled processes. Our model is also trait-based, which allows individuals to vary in life history characteristics, making it possible to mechanistically link the resulting variability in settlement probabilities to underlying traits (e.g. spawning date and location, pelagic larval duration or PLD, body morphology, etc.). We use our biophysical model to examine how biology interacts with the physical environment

to shape settlement predictions for reef fish off western and southern Hawai‘i Island. Linked to prevailing surface currents, we find increased probabilities of settling when PLDs are short and fish are spawned in southern and southwestern locations. As well, eddies, common to leeward Hawai‘i Island, offer a second pathway to successful settlement for individuals with longer PLDs. Finally, we illustrate how lunar-timed spawning as well as adaptive morphological features (e.g. fin and head spines) may vary settlement success by altering the mortality landscape experienced by the larvae. This work identifies life history characteristics that predict the self-recruitment pathways necessary for population persistence for west Hawai‘i Island. Our results can be used to develop future hypotheses regarding temporal and spatial variation in community structure and recruitment for reef fishes on Hawai‘i Island and beyond.

**5 December, 4:25 PM**

**Surface Slicks as Important Nursery Habitat for Larval Fish in West Hawai‘i**

**Whitney, J.L.**[1,2,3], Smith, K.A.[1,3], Gove, J.M.[2], Lecky, J.[1,2], Copeland, A.[4], Kobayashi, D.R.[2], McManus, M.A.[3]

[1]Joint Institute for Marine and Atmospheric Research, University of Hawai‘i at Mānoa, Honolulu, Hawai‘i
[2]NOAA, Pacific Islands Fisheries Science Center, Honolulu, Hawai‘i
[3]Department of Oceanography, University of Hawai‘i at Mānoa, Honolulu, Hawai‘i
[4]NOAA, Office of Ocean Exploration and Research, Silver Spring, MD

Identifying essential nursery habitats used by larval and juvenile fishes has become a critical component of Ecosystem-Based Fisheries Management (EBFM). Surface slicks - narrow, meandering lines on the surface ocean - are a conspicuous feature off the coast of west Hawai‘i and may be important to early life stages of coastal fishes. Here, we present results from an interdisciplinary study that aims to determine the degree to which larval and juvenile fishes utilize surface slicks as a nursery habitat. Our team conducted two intensive cruises, the first in 2016 and the second in 2017, in and around surface slicks off the coast of west Hawai‘i. Plankton tows were coupled with hydrographic profiling to simultaneously characterize the planktonic community as well as the underlying physical structure. We provide evidence that slicks accumulate and concentrate phytoplankton, zooplankton, and larval fish, as well as organic and inorganic debris. We found that a diverse assemblage of fish larvae from more than a dozen families of reef-associated and coastal pelagic fish were found to be strongly associated with slicks. On average, larval fish densities were nearly an order of magnitude higher inside surface slicks than in the adjacent water. Moreover, the size/age structure of slick-associated fishes also varied significantly among taxa, with some genera accumulating at early, pre-flexion stages, and others aggregating at late-larval or juvenile stages. The higher abundance of phytoplankton and zooplankton prey in slicks likely enhances larval growth and survival and the movement patterns of slicks are likely to have important implications for larval transport and recruitment. The strong relationships between larval abundance and slick habitats suggests that these oceanographic features may have considerable impact on early life history of many commercially important fish.

**5 December, 4:40 PM**

**Physical Drivers of West Hawaii's Surface Slicks and their Effects on Larval Fish**

**Katharine A Smith**[1,2], Jonathan L Whitney[1,2,3], Joey Lecky[2,3], Adrienne M Copeland[4], Jamison M Gove[3], Donald R Kobayashi[3], Margaret A McManus[1]

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[2] Joint Institute for Marine and Atmospheric Research, University of Hawai'i at Mānoa, Honolulu, Hawai'i
[3] Pacific Islands Fisheries Science Center, National Oceanic and Atmospheric Administration, Honolulu, Hawai'i
[4] Office of Ocean Exploration and Research, Oceanic and Atmospheric Research, National Oceanic and Atmospheric Administration, Silver Spring, Maryland

Lines of smooth surface water, or "slicks," are common features in the nearshore waters off Hawaii's Kona coast. Samples from an interdisciplinary oceanographic study showed that larval fish accumulate in greater concentrations within these slicks than in nearby surface waters outside of the slicks, indicating that they are significant components of the local fish nursery habitat. Our physical observations identified multiple mechanisms that form slicks in this region including internal waves, headlands, groundwater discharge, and Langmuir cells. Internal wave slicks were the most common type of slick and were also the type associated with the greatest accumulation of fish larvae. Other aspects of the physical habitat also affected larval fish accumulation in slicks, including tides, winds, and north/south location along the coast. Understanding ways that the physical environment affects fish nursery habitat will aid ecosystem and fisheries management by helping to anticipate the effects that environmental variability, such as that associated with El Niño/La Niña or climate change, may have on physical features in the water column and consequently on fish populations.

**5 December, 5:00 – 6:30 PM**

**Information Booth Session**

Meet the following local organizations making positive contributions to science, conservation and management related to the marine ecosystem in West Hawai'i

Dolphin Quest
Large Whale Entanglement Response Team
Hawai'i Uncharted Research Collective
The Kohala Center
University of Hawai'i at Hilo Analytical Lab
Hawai'i Division of Aquatic Resources
Ocean Defenders Alliance
NOAA Marine Debris Program
Coral Reef Alliance
Conservation International Hawai'i
Hawai'i State Parks

# Symposium on West Hawaii's Marine Ecosystem: Bridging the Gap Between Science and Management

## Presentation Abstracts

## 6 December 2017

**6 December, 9:00 AM**

**Coastal and Ocean Observations and Forecasts to Support Place-based Science and Management**

**Langenberger, F.**

Pacific Islands Ocean Observing System (PacIOOS), Honolulu, Hawai‘i

The Pacific Islands Ocean Observing System (PacIOOS) empowers ocean users and stakeholders throughout the Pacific Islands by providing accurate and reliable coastal and ocean information, tools, and services that are easy to access and use. By collecting data on the most recent ocean conditions, forecasting future events, and developing new user-friendly tools, PacIOOS strives to inform scientists, resource managers, non-profit organizations, and communities. PacIOOS currently owns and operates a wave buoy and a water quality buoy on Hawai‘i Island. Plans are underway to deploy a second water quality buoy in Pelekane Bay, which will collect valuable data to inform ridge to reef research and management. Along with high-resolution atmospheric, wave, and ocean forecasts and hindcasts, PacIOOS also generates high sea level forecasts for Kawaihae Harbor and Hilo Harbor to predict higher than normal sea levels for the upcoming six days. All of these data are easily accessible on the PacIOOS website and on PacIOOS' interactive data portal *Voyager*. To increase data accessibility, PacIOOS collaborates with partners to enable access to research data and information by creating project-specific map viewers and project pages. PacIOOS *Voyager* features numerous data sets, including real-time, forecast, satellite, and historical data. Through user-friendly functionalities *Voyager* is a handy platform for scientists and decision-makers to view, overlay, download, and share data. Based within the School of Ocean and Earth Science and Technology (SOEST) at the University of Hawai‘i at Mānoa, PacIOOS is one of 11 regional associations that make up the U.S. Integrated Ocean Observing System.

**6 December, 9:15 AM**

**Pelekane Bay Water Quality Buoy: A New Resource for Coastal Ocean Management**

**Colbert, S.L.**[1], Adolf, J.[2], Iwamoto, M.[3]

[1]Marine Science Department, University of Hawai‘i at Hilo, Hilo, Hawai‘i
[2]Department of Biology, Monouth University, West Long Branch, NJ
[3]Pacific Islands Ocean Observing System, University of Hawai‘i at Manoa, Honolulu, Hawai‘i

With an extensive fringing coral reef ecosystem, numerous federally-listed endangered and threatened species, known threats to the ecosystem, and ongoing conservation efforts, Kawaihae Harbor and Pelekane Bay are within priority regions for research and management identified by the State of Hawai'i and NOAA. Pelekane Bay suffers from high turbidity resulting from excessive erosion in the surrounding watershed combined with sluggish circulation and has been placed on the Hawai'i 303d list of impaired water bodies. During the 2015 coral bleaching event, which was a result of high seawater temperatures, DAR divers reported >75% coral bleaching at Kawaihae. To provide data for management and research in this critical ecosystem, we are installing a water quality buoy approximate 0.8 km (0.5 mi) offshore from Spencer Beach Park. The buoy (YSI EMM 68) sits approximately 0.6 m (2 ft) above the water line and will provide continuous measurements of water quality, including salinity, temperature, dissolved oxygen, chlorophyll and turbidity in the surface water. The buoy will be maintained by the University of Hawai'i at Hilo with support from the Pacific Islands Ocean Observing System (PacIOOS). Near real-time data will be available on the internet through the PacIOOS website. Since the buoy is continuously deployed,

data is collected even during conditions that are not conducive to field sampling, such as during storms and at night. Data from the buoy will be useful for individuals, educators, and organizations interested storm-related water quality issues, local temperature maximums that lead to coral bleaching, and other management needs.

**6 December, 9:30 AM**

**Linking Wastewater and Fertilizer Inputs to Coral Reef Health: Integrating Monitoring and Modeling Approaches for Conservation Planning**

**Kim Falinski**[1], Courtney S. Couch[2], Rebecca Most[1], Kristina Remple[3], Chad Wiggins[1], Craig Nelson[3], Eric Conklin[1]

[1]The Nature Conservancy, Honolulu, Hawai‘i
[2]Hawai‘i Institute of Marine Biology, Kāne‘ohe, Hawai‘i
[3]Center for Microbial Oceanography: Research and Education, Department of Oceanography and UH Sea Grant, University of Hawai‘i at Mānoa, Honolulu, Hawai‘i

Increasing human populations in Hawaii’s coastal regions combined with ineffective wastewater and fertilizer management land use practices have resulted in deteriorated water quality and impaired reef health in many areas around the state. However, the extent to which water quality in West Hawai‘i has been affected and how that impacts coral health is not well understood. While the effects of inadequate wastewater treatment have been intensively studied by independent researchers at Puakō (where coral cover has declined by 50% during the last 40 years), less is known about the origin of land-based inputs and reef impacts elsewhere along the West Hawai‘i coastline which is experiencing rapidly growing residential and resort development. We present two approaches to assessing spatial variability in land-based pollutants in coastal West Hawai‘i waters – first, a field program that investigated the relationship between land use types, water quality and coral health across a range of coastal development intensities. We measured fecal indicator bacteria (FIB), dissolved inorganic nutrient concentrations, $\delta_{15}N$ in macroalgae, and coral health to assess contributions from land and test correlations between coral health and environmental metrics. Second, we combined this information with a nutrient export model (InVEST NDR) that estimated nutrient contributions by land cover and use type, including golf courses, landscaping, presence of on-site waste disposal systems, and natural nutrient inputs. We analyzed the results based on proximity of these sources to the ocean. Preliminary field results indicate the presence of elevated land-based inputs at multiple shoreline sites. Model results showed that the highest coastal nitrate concentrations corresponded with nutrients originating within 2km of the coast, indicating that near-coast inputs might be the most important to reduce to improve coastal water quality. This project is designed to assess the extent of these land-based threats and provide up-to-date information that can be integrated into conservation planning and management action.

**6 December, 9:45 PM**

**Spatial Distribution and Sources of Land-Based Dissolved Inorganic Nutrients at Coral Reefs in South Kohala**

**Panelo, J.**[1], Wiegner, T.N.[1], Abaya, L.M.[1], Colbert, S.L.[1], Kauahi, C.[1], Goldberg, S.[2], Couch, C.[3], Falinski, K.[3], Wiggins, C.[3], and Gove, J.[4]

[1]Marine Science Department, University of Hawai'i at Hilo, Hilo, Hawai'i
[2]NOAA Pacific Islands Regional Office, Honolulu, Hawai'i
[3]The Nature Conservancy Hawai'i, Honolulu, Hawai'i
[4]NOAA Pacific Islands Fisheries Science Center, Honolulu, Hawai'i

Hawaii's coral reefs are declining due to anthropogenic impacts and multiple stressors. Land-based sources of pollution (LBSP), including transport of elevated concentrations of dissolved nutrients via surface and groundwater flows, is a stressor that is harmful to reefs in Hawai'i. Previous research in South Kohala found that coral reefs are in decline. To help better manage these coral resources, the State of Hawai'i has developed a Coral Reef Strategy with a goal to implement actions that reduce such anthropogenic threats. While ongoing research in South Kohala, largely in Puakō, aims to understand impacts of sewage pollution on coastal distributions of dissolved inorganic nutrients and coral reef health, more research is needed to identify and assess impacts of other nutrient sources to coral reefs beyond Puakō. The project presented here which is a collaborative effort among University of Hawai'i at Hilo, University of Hawai'i at Mānoa's Hawai'i Institute of Marine Biology, The Nature Conservancy, and NOAA's Habitat Blue Print West Hawai'i Habitat Focus Area program, expands on the methods to assess LBSP developed at Puakō by examining (1) the distributions of land-based dissolved inorganic nutrient sources in Pau'oa and Kūki'o Bays, and (2) related variation in coral reef health at these locations. This presentation will describe our efforts to assess the variability in the concentrations and sources of dissolved nutrients over gradients from upland wells to the surface and benthic waters of each bay. This information, in conjunction with salinity and temperature measurements, will be used to determine reef exposure to land-based nutrients, and later to examine potential relationships with coral reef health. Understanding water quality impacts from anthropogenic sources to reefs is vital to developing recommended actions that ensure the resilience potential of coral resources in a changing climate.

**6 December, 10:00 AM**

**Sewage Pollution Source Tracking On South Kohala Reefs**

Aguiar, D.[1], Wiegner, T.[2], Abaya, L.[2], Stewart, J.[2], Beets, J.[2], Couch, C.S.[3], Colbert, S.[2], [4]Nelson, C.

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[2]University of Hawai'i at Hilo, Marine Science Department, Hilo Hawai'i
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[4]University of Hawai'i at Mānoa, School of Ocean and Earth Science and Technology, Honolulu, Hawai'i

Puakō has some of the richest coral reefs in the state of Hawai'i; however, there has been an increasing concern about sewage pollution since the 1960s. Recent studies from the Hawai'i Division of Aquatic Resources and The Nature Conservancy estimate that coral cover at Puakō has decreased 35-40% in the

last 30 years, prior to the 2015 bleaching event. Currently, fecal indicator bacteria (*Enterococcus* spp., *Clostridium perfringens*, and human associated *Bacteroides* molecular marker) and stable isotope nitrate analyses ($\delta^{15}N$ and $\delta^{18}O\text{-}NO_3^-$) are being used to determine if sewage is present on the reefs, as well as its percent contribution to benthic $NO_3^-$ concentrations. Benthic and coral health surveys are also being conducted to better understand how land-based inputs are affecting the benthic community structure. Our continued monitoring efforts will include measurements of water circulation and the creation of a mixing model, to determine the exposure time of sewage on the reef.

**6 December, 10:15 AM**

**Identifying Locations of Sewage Pollution within Puakō's Watershed and Comparison of On-Site Sewage Disposal Systems for Management Actions**

**Wiegner, T.N.** [1], Abaya, L.M. [1], Colbert, S.L. [1], Panelo, J. [1], Adnan Sultan, S. [2], Sharif, A. [3], Demapan, C. [1], Remple, K. [4], and Nelson, C[4].

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[2]University of Northern Florida, Jacksonville, FL
[3]Moravian College, Bethlehem, PA
[4]Center for Microbial Oceanography Research and Education, University of Hawai'i at Mānoa, Honolulu, Hawai'i

Determining the location of sewage pollution in a watershed is important for implementing management actions to reduce pollution impacts on coral reefs. Our study's goal was to identify locations of sewage pollution in the Puakō watershed on Hawai'i Island. Puakō is a coastal community with a fringing reef whose coral cover has decreased 50% in the last 40 years, and sewage pollution is thought to be one of the culprits. To achieve our goal, sewage indicators [fecal indicator bacteria (FIB: *Enterococcus* spp., *Clostridium perfringens*, human-associated *Bacteroides*), stable nitrogen isotopes of nitrate ($\delta^{15}NO_3^-$), nutrients] were measured in groundwater at high, mid-, and low elevation sites, as well as along the shoreline. Dye tracer tests, water quality, and $\delta^{15}N$ macroalgal measurements assessed differences in water quality impairment caused by different onsite sewage disposal systems (OSDS). *Enterococcus* spp. concentrations often exceeded state standards along Puakō's shoreline, while upslope wells and resorts' shoreline waters had low concentrations. *Clostridium perfringens* concentrations exceeded the recommended state standard for marine recreational waters, with several Puakō stations having values indicative of non-point source sewage pollution. Positive hits for human *Bacteroides* only occurred at Puakō. $\delta^{15}NO_3^-$were indicative of sewage pollution at Puakō, while values upslope and at adjacent resorts were indicative of soil and fertilizers. These findings confirm that sewage is largely entering the water table at Puakō as evidenced by the high levels of sewage indicators measured along its shoreline. Dye was detected in front of all dye tracer test sites, reached the shoreline within 5 h to 10 d, and all OSDS types had examples of sewage reaching the shoreline in less than 1 d. Concentrations of FIB and nutrients were also similar in front of these sites. These results suggest that the underlying geology likely controls how fast sewage flows from the OSDS to the shoreline, not the system type. Our findings highlight the need for improved sewage treatment and collection at Puakō, and demonstrate that our multiple sewage indicator approach for identifying locations of sewage pollution within a watershed was successful and can be used by other coastal communities addressing similar issues.

**6 December, 10:45 AM**

## West Hawai‘i Habitat Focus Area Partnership: Science, Restoration, Conservation and Community Action

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West Hawai‘i was selected as a NOAA Habitat Focus Area because of its unique coastal ecosystems, known threats to these ecosystems, multiple on-going conservation efforts, and the strong foundation of partnerships and community involvement. NOAA, The Nature Conservancy, and multiple state and federal partners are working collectively to increase the effectiveness of our efforts in this important habitat. The coral reef habitat along West Hawai‘i are a vital component of the community ecosystem, supporting an abundance of corals and fish, of which nearly a quarter are found nowhere else in the world. From its significant cultural sites to its thriving resort industry, West Hawai‘i is important to the region’s economy, history, culture, and environment.

NOAA’s West Hawai‘i Habitat Focus Area (WHHFA), located in South Kohala and North Kona, has the goal to improve habitat and community resilience to climate change and other threats to habitat loss including ocean warming, sediment and nutrient loading, and overharvesting of coral reef fishes. To help achieve this goal, the WHHFA has the following objectives listed below.

- Improving coral health by reducing land-based pollutants, such as sediments and nutrients.
- Reducing vulnerability of communities and natural resources to the localized effects of climate change.
- Ensuring that communities are informed and contribute to the sustainable use and restoration of natural resources.
- Providing better management tools and easily accessible information for informed decisions.

This presentation will highlight the progress, successes, and next steps for the scientific, restoration, conservation and community action projects and activities that are ongoing between NOAA, The Nature Conservancy (TNC) and other partners in the WHHFA. The presentation will touch on aspects of the following topics: coral reef resilience studies, sea level rise assessment? coastal water quality research, erosion and sedimentation mapping and restoration, fish pond restoration. All stakeholders are encouraged to attend.

**6 December, 11:00 AM**

## Working Together to Understand, Quantify and Manage for Tipping Points on the Reefs of Hawai‘i

Selkoe, K.[2], Oleson, K.[1], Kappel, C.[2], **Donovan, M.**[1], Friedlander, A.[1], Lecky, J.[3], Jouffray, JB[4], Williams, G.[6], Falinsky, K.[8], Gove, J.[3], Wedding, L.[7], White, C.[5]

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[8]The Nature Conservancy, Honolulu, Hawai‘i, USA

Tipping points occur when small shifts in human pressures or environmental conditions bring about large, sometimes abrupt changes in a system – whether in a human society, an ecosystem or our planet’s climate. This talk overviews the Ocean Tipping Points project, a multi-year, multi-organization collaboration of scientists and management partners that seeks to guide new approaches to ocean management with integrative science. We present results of our research on ecological shifts on Hawaiian reefs and discuss implications for reef management. By integrating an unprecedented body of newly synthesized benthic and fish community data and novel, spatially explicit datasets representing environmental and anthropogenic drivers across the Main Hawaiian islands, we provide evidence for 5 distinct reef regimes and nonlinear relationships between regimes and their human impacts. These quantified relationships can provide
reference points to inform targets for reef protection and restoration. Using an economic tradeoff analysis, we demonstrate the costs and benefits of different management actions aimed at reaching management targets. We focus in on Kona, and conclude by discussing how these analyses are supporting efforts to mitigate local stresses and enhance resilience of Hawaiian reefs.

**6 December, 11:15 AM**

## An Ocean Health Index for West Hawai‘i

**Eva Schemmel**[1], Jack Kittinger[2], Joey Lecky[3,4], Jamison Gove[4]

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The West Hawai‘i Ocean Health Index is being developed to measure and track the benefits and services the ocean provides to the residents of Hawai‘i now and into the future. Overall Index scores are a combination of components, or ‘goals’, of ocean health (Food Provision, Fishing Opportunities, Sustainable Tourism, Sense of Place, Biodiversity, Livelihoods and Economies, Coastal Protection, and Natural Products). Goal scores are calculated using the best available data and indicators at the scale of

the assessment. Scores reflect how well coastal regions optimize their potential ocean benefits and services in a *sustainable way relative to a reference point* (target), on a scale of 0-100. This index is being created with the support of local stakeholders to better understand how to sustainably balance current and future ocean uses. We defined "health" as a state of being that is pono (righteous, proper, in balance), where functions and processes can exist, perpetuate, and evolve, including the presence and role of humans. To achieve a healthy ocean, several actions were suggested including: getting control of shoreline development and its impacts, reducing land-based pollution sources, feral cat control, sustainable fishing practices, invasive species management, reducing the impacts of tourism, and incorporation of traditional Hawaiian resource management practices and values. The West Hawai'i Ocean Health Index combines these key actions with other biological, physical, economic, and social elements into one assessment to allow for a better understanding of the impacts of diverse ocean uses on the sustainability of our ocean and provide context to support management decisions.

**6 December, 11:30 AM**

**Monitoring Human Behavior and Perceptions in Hawai'i Through NOAA's National Coral Reef Monitoring Program (NCRMP)**

**Levine, A.**[1], Gorstein, M.[2], Edwards, P.[3], Loerzel, J.[2]

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NOAA's Coral Reef Conservation Program is now incorporating socioeconomic monitoring into the National Coral Reef Monitoring Program (NCRMP), which monitors the status and trends of coral reef ecosystems in U.S. jurisdictions with coral reefs. The socioeconomic monitoring component gathers information on a range of socioeconomic indicators such as demographic change, use of coral reef resources, and knowledge, attitudes, and perceptions of coral reef resources and management. The overall goal is to track relevant information regarding socioeconomic factors in order to investigate people's interactions with coral reefs, the impacts of society on coral reefs, and the contributions of healthy corals to nearby communities.
A phone survey of 2,240 adult residents of the Main Hawaiian Islands was completed in 2015, with a total of 620 surveys conducted on Hawai'i Island. This presentation will highlight summary findings from the survey, both for the state of Hawai'i, as well as outcomes specific to Hawai'i Island and directly relevant to West Hawaii's marine ecosystem. Survey topics covered include: resident participation in coral reef-related activities (e.g. fishing, diving, swimming, snorkeling), residents' knowledge of threats to coral reefs, local perceptions of marine resource condition, support for coral reef management strategies, and understandings of community involvement in coral reef management. Results indicate widespread general support for marine management activities and familiarity with coral reef threats, as well as mixed levels of participation in extractive coral reef related activities. These results are currently being incorporated into the NCRMP report card for Hawai'i and data are available for local researchers and managers to better inform local management planning.

**6 December, 11:45 AM**

## Exploring Oceanic Whitetip Shark Interactions in Hawaii's Small-Scale Fisheries Through Fisher Engagement

**Iwane, M.A.**[1,2,3], Leong, K.M.[2], Oleson, K.L.L.[1], Hutchinson, M.R.[3,4,5]

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[5]Hawaii Institute of Marine Biology, Kaneohe, Hawai'i

The National Marine Fisheries Service (NMFS) published its proposal to list the oceanic whitetip shark (OCS) as threatened under the Endangered Species Act (ESA) in December of 2016. The OCS' pending ESA listing highlights a need for more robust shark interaction data in Hawaii's small-scale fisheries, and an opportunity to collaborate with fishery participants to pursue OCS mortality reduction strategies. This study addresses both of these through semi-structured interview with members of Hawai'i Island's small-scale fishery. Interviews explore fisher experience and perspective with respect to OCS (and other pelagic shark) interactions, information sharing within the fishery, and the feasibility of OCS mortality mitigation strategies. Fisher interviews began in September of 2017 and will continue through 2018 until interview themes become saturated. Preliminary results have identified the charter and commercial handline fisheries as those most likely to interact with pelagic sharks, though OCS interactions are relatively uncommon. While the seasonality of some shark species has emerged, patterns in OCS presence outside pilot whale- and FAD-associative behavior are not apparent. Respondents indicate that shark interactions are an accepted, inevitable part of fishing due to the unpredictability of shark presence. Distinct solutions for OCS mortality reduction have not yet emerged. However, fishers' preference for passive shark deterrence and their scientist-like curiosity highlight potential for collaborative shark mitigation efforts and outreach success. With regard to fisheries management, fisher frustration seems to stem primarily from manager disconnect from the realities of fishing. Specific solutions, again, have not emerged, but should involve improved understanding and communication between fishers, scientists, and managers. The nature of this work, which seeks to amplify the voices of fishermen, engage them early, and assign them an active role in solution development, has implications for improved communication between local fishermen, research institutions, and government agencies, and better-informed management.

**6 December, 12:00 PM**

## Revealing Complex Social-Ecological Interactions Through Participatory Modeling in Hawai'i

**Ingram, R.J.**[1,2], Oleson, K.L.L.[3], Gove, J.M.[2]

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The Hawaiian Islands are home to a complex and dynamic marine ecosystem that serves as a backbone to the state's economy and society's well-being. The marine ecosystem currently faces numerous threats that undermine ecosystem integrity and compromise socially valuable ecosystem services. The socio-economic and ecological complexity of the region invokes a clear need for Ecosystem Based Management (EMB) strategies. To support EMB development, we used participatory methods to gather expert and place-based knowledge from resource managers, scientists, and community members. Methods elicited local values, fostered diverse relationships, and increased community engagement in resource management. Using information collected, we developed Conceptual Ecosystem Models guided by the Driver-Pressure- State-Impact- Response framework that identify and quantify the strength of socio-economic and ecological interactions. The resulting models illustrated the complexity of system dynamics, highlighting connectivity between pressures and the ecosystem, with direct implications for ecosystem services. Importantly, many identified pressures occur at the local scale, presenting an opportunity for local resource management to directly affect ecosystem status. We also found that many of the strongly impacted ecosystem services were cultural ecosystem services, which are critical to human well-being but lack integration into resource management. These models support an Integrated Ecosystem Assessment of the region by informing ecosystem-based strategies, facilitating the selection of ecosystem monitoring indicators, and emphasizing human dimensions.

**6 December, 12:15 – 1:45 PM**

**Lunch Session: Working together to represent communities within the West Hawai‘i IEA**

How do you value and connect with the ocean? For many people, the answers to this question will include things that cannot be held, but rather must be experienced or perceived. Answers may not have a market value or be considered a market commodity; however, they are incredibly valuable to your quality of life and well-being.

Our natural environment provides us with a multitude of goods, services, and benefits that we value (often called cultural ecosystem services). Many of these cannot be physically held or appropriately quantified. NOAA's Integrated Ecosystem Assessment (IEA) recognizes the importance of the connections between communities and their environment, and the significant role that the environment plays in their well-being. A primary goal of the IEA is to ensure that human well-being is incorporated in resource management, including the values and aspirations a community may have. The importance of this concept has been increasingly recognized in recent years, yet specific ways to implement and incorporate it into resource management are still in early development stages. It is widely recognized, however, that failing to incorporate cultural services in management strategies can jeopardize a community's well-being. Finding a way to translate intangible social elements is imperative, which is why the West Hawai‘i IEA is investigating this crucial topic.

The goal of this discussion session is not to solve this issue in one day. Rather, it is a first step within a larger process. In this session, we will briefly go over how the West Hawai‘i IEA has begun to look at human dimensions and cultural services. We will then break into groups to discuss the well-being of both social and natural systems in West Hawai‘i. This session will help to shape future steps in this process of incorporating human well-being into the West Hawai‘i IEA, and serve as a guide for IEA's in other locations.

*We invite you to bring your lunch, and join this discussion to provide your insights on this important topic.*

**6 December, 1:45 PM**

**Movement Behavior and Habitat Use of Pelagic Predators in the Waters Surrounding West Hawai‘i**

**Hutchinson, M.**[1,2,3], Coffey, D.[3], Royer, M.[3], Holland, K.[3]

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[3]Hawaii Institute of Marine Biology, Kaneohe, Hawai‘i

Pelagic shark populations are declining in many regions worldwide. Commercial fisheries on the high seas have been implicated as major contributors to these declines due to high rates of fishing mortality to blue, *Prionace glauca*, bigeye thresher, *Alopias superciliosus,* mako, *Isurus oxyrhincus*, silky, *Carcharhinus falciformis*, and oceanic whitetip, *C. longimanus,* sharks. These species are all encountered seasonally in the waters surrounding west Hawai‘i and are often incidentally captured in several local, small scale fisheries. Several of these species also inflict high rates of depredation, drastically reducing the value of the catch for fishers operating in the area. Due to the conflict arising from these interactions, many sharks are killed, which may have compounding effects if this region is being utilized for biological imperatives such as; reproduction, feeding or as a nursery area. This study is designed to engage local fishers in a collaborative tagging effort to understand the movement behavior, habitat use and residency patterns of these species in west Hawai‘i. Additionally, fishers have been tasked with devising testable methods to deter sharks from the catch and in the development of non-lethal bycatch mitigation strategies.

**6 December, 2:00 PM**

**Persistent and Dense Concentrations of Micronekton along the Kona Coastline**

**Jeffrey C. Drazen**[1], Bethanie Francis[2], Jamison Gove[3], Don Kobayashi[3], Adrienne Copeland[4], Jana Phipps[1,3], and Gareth J. Williams[2]

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The Kona coast is known for supporting an abundance of whales, dolphins, and pelagic fishes but the reasons for this are unknown. A combination of midwater trawl and active acoustics (38 and 70 kHz) was used to investigate the community of potential prey, small fishes, squids and shrimps called micronekton. Cruises were conducted in 2011, 2013, 2014, 2016 and 2017. Acoustic backscatter (indicative of micronekton biomass) was very high at depths of 400 to 650m close to the coast, between the 1000 and 2000m isobaths. This backscatter was present both day and night indicating that the fauna were largely not displaying vertical migrations. Importantly these results were evident in all years indicating that the micronekton biomass concentration was persistent over time. Nighttime epipelagic trawl sampling has shown that the nearshore micronekton included a larger abundance of species known to be near-island associated. In 2016 and 2017 trawls were conducted that sampled the deeper nonmigratory biomass nearshore and offshore. Micronekton abundance was three times higher nearshore than offshore but the average size of the animals was smaller and thus overall biomass was similar. The high abundance was primarily due to serrivomerid eels and gonostomatid fishes. Several larger squids also contributed to nearshore biomass. The concentrations of micronekton may be the result of increased primary production

nearshore due to the island mass effect or could be the result of local currents and advection concentrating the animals. Efforts are underway to evaluate these potential drivers. Regardless, the concentrations of micronekton nearshore to the Kona coast may provide an important food source for marine mammals and pelagic fishes in the region.

**6 December, 2:15 PM**

**An Assessment of Mesophotic Reefs in Hawai‘i as Fishing and Climate Change Refugia**

**Caldwell Z.R.**[1], Zgliczynski B.J.[2], Conklin E.J.[1], McDonald C.M.[2], Sandin S.A.[2]

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[2]Scripps Institution of Oceanography, Center for Marine Biodiversity and Conservation, La Jolla, CA

Our understanding of how natural and anthropogenic factors influence the structure and function of coral reef communities has advanced rapidly over the past 30 years. However, most monitoring programs and research studies have been limited to shallow (< 30 m) coral reef habitats. Recent work suggests that the linear extent of deeper, mesophotic reefs (30 – 150 m) could rival or exceed that of shallower reefs. Additionally, important fisheries targets are thought to utilize mesophotic habitats and forage across depths. Therefore, our current ecological understanding of mesophotic reefs and how they are ecologically linked to shallow reef environments is rudimentary. The goal of this collaborative project is to complement existing long-term shallow coral reef monitoring efforts in West Hawai‘i by establishing an ecological baseline for mesophotic reefs along the leeward coastline. To accomplish this goal our team is conducting a series of high-resolution surveys to characterize fish and benthic communities at a subset of sites exposed to varying levels of human impact (e.g., fishing and aquarium collection). Using standardized approaches to survey fish communities and novel large-area underwater imaging techniques, we describe reef communities across depth (10m-60m). As expected, shallow reef communities were comprised primarily of herbivorous and omnivorous fishes as well as an abundance of calcifying organisms. However, with increasing depth, we found changes in reef fish assemblage structure including reduced fish biomass and a benthic community less comprised of calcifying organisms. Our team has plans to conduct a second round of ecological surveys in 2018 to examine the consistency of these results and investigate changes in community structure across depth in further detail. Our results provide important insights into the structure and function of coral reefs and increases our understanding of how coral reef management is realized across the extent of reef communities on the island of Hawai‘i.

**6 December, 2:30 PM**

**In-situ Measurements of Environmental Variables at Keahole and other Hawaiian Deep Sea Coral Beds**

**Parrish F.**[1], Oliver T.[2], and Clark J.[2]

[1]NOAA Pacific Islands Fisheries Science Center, Honolulu, Hawai‘i
[2]Joint Institute of Marine and Atmospheric Research, Honolulu, Hawai‘i

Current meters were used to measure the flow rate, direction and temperature of water movement at three sites where the sea floor morphology and the dominant coral community differed (even-bottom with *Coralliidae*, ledge-top with Keratoisidinae & *Kulamanamana haumeaae*, pinnacle summit with *K.*

*haumeaae*). Duration of the deployments ranged between 7 and 30 months with the average flow rate found to be slowest (4.5 cm/sec) at the ledge-top site. The fastest flow rate (13.6 cm/sec) was seen at the even-bottom site where the direction of the current remained the most consistent. The timing and intensity of flow appeared related to tidal forces but the temporal scale of the cycle was markedly different between the ledge-top site which was located on the west coast of the Big Island of Hawai‘i and the two other beds located at the southeast end of the island of Oahu. Smaller differences in flow rates within each coral bed were identified using independent flow meters placed elsewhere to get a range of values acceptable to coral settlement and growth. Understanding the composition of these coral assemblages and relating in-situ environmental observations to broader scale oceanography can improve our ability to model deep sea coral occurrence.

**6 December, 2:45 PM**

**Effects of Open Circuit SCUBA Exhaust on Reef Fish Surveys**

**Lopes Jr., K.H.**

NOAA’s Papahānaumokuākea Marine National Monumnet, Honolulu, Hawai‘i

The predominate method to quantify reef fish populations for fisheries managers is the Open Circuit SCUBA (OC) in-situ fish survey. However, there are many biases associated with these surveys including the expelled OC exhaust, which can cause visual and audible disturbances. This study aims to evaluate the bias created by OC exhaust utilizing closed-circuit rebreather (CCR) surveys, along with paired OC surveys. Additionally, to determine differences due to fishing pressure, these surveys were conducted in protected areas and fished areas. The three sites in the main Hawaiian Islands were Kealakekua Bay (KK), Old Kona Airport (OA), and Pūpūkea (PK) marine life conservation district. This study found that the total fish biomass and species richness from all sites pooled showed no significant differences between gear type. There was a significant interaction between the gear type and the protection status ($Pr(>|t|) = 0.025$), meaning the OC and CCR have greater differences in the fished areas than the protected areas. When fished species were examined, significant differences between gear types were shown with all sites combined ($Pr(>|t|) = 0.010$) and at OA ($Pr(>|t|) = 0.012$). The OC surveys showed more fished biomass than the CCR surveys which could mean that the attraction to the exhaust within the protected areas were greater than the repulsion of the exhaust in the fished areas. These significant differences in the fished species and no difference in the all fish biomass supports previous studies findings that fishing pressure is very influential. For researchers, estimating fishing pressure is of high importance in order to assess the level of bias associated with OC exhaust on surveys. These bias needs to be accounted for in population estimations for protected areas and non-protected areas in order to get more detailed biological fish data.

**6 December, 3:15 PM**

**Reef Fish Aquaculture in Kona**

**Kraul, S.**

Pacific Planktonics, Kailua-Kona Hawai‘i

Aquaculture has been suggested as a means to replace collection of aquarium fishes in Hawai‘i, or to restock our reefs with depleted species. Technology for these projects has evolved to the point where some aquarium fish can be raised profitably, but there are still limits to our ability to raise the whole reef. Forty years ago we could only raise a few species of marine fish, and most of them required access to wild plankton. Harpacticoid copepod culture in 1980 made a huge difference in growth and survival, and the number of species we could raise. This discovery led to the diagnosis of nutrient (DHA) deficiency in standard feeds, such as rotifers and artemia. The subsequent development of enrichment (Selco) for standard feeds increased hatchery culture of many species, mainly food fish. Due to the small mouth gape of larvae at first feeding, dependable culture of marine aquarium fishes required the discovery of a smaller Calanoid copepod in 2001. Progress since 2001 has depended primarily on the efforts of scientists with long experience and a tolerance for low funding.

It is still difficult to raise the fishes that we associate with our corals in Hawai‘i. Pacific Planktonics has previously produced larval food fish, such as mahimahi, tuna, kahala, moi, and other edible species, but we currently focus on ornamental species. We will present pictures of these exotic larvae, and discuss technical and financial limitations to their production,

**6 December, 3:30 PM**

**Rebuilding Our Coral Reefs One Polyp at a Time**

**Coney, B.**

Legacy Reef Foundation, Kamuela, Hawai‘i

The Legacy Reef Foundation was founded on an idea that when a group of committed people and scientists come together and work collaboratively with other coral labs, together we might be able to make changes in the world’s coral reefs, and maybe, possibly, begin to see depleted reefs return to their former glory and reestablish food security and sea defense. We believe that coral “seeds” can be developed that will be stronger and more resistant to the effects of global warming. These “seeds”, tiny as they are, when affixed to a dead reef can begin to reestablish coral reefs over time. By farming coral that is resistant to the effect of global warming, and replanting them as needed, depleted reefs can accelerate their recovery and bring back food security closer to shore.

Countries like Papua New Guinea have lost much of the coastal reefs to 50 years of destructive mining practices. Much of the coastal population relies on fishing for substance but now they must fish miles off shore and many are lost because long distances they must travel to find fishing grounds. The Prime Minister of Papua New Guinea told me that his number priority is food security for his coastal people. Our goal is to use best practices develop procedures to create bleach resistant corals from local stock and build “containerized” labs that will be shipped to countries in need, to re-establish local reefs creating food security and sea defense to protect the local villagers.

Low resource areas will gain the tools needed to support reef restoration in their backyard. The local community is trained in coral growing practices and in marine conservation. These skills will transfer into supporting responsible eco-tourism and accelerating the recovery of their reefs. Fishing will return close to the shore, decreasing fishing related mortality, and additional sources of revenue will be available through ecotourism.

**6 December, 3:45 PM**

**Marine Aquaculture Opportunities in West Hawai‘i**

**Stevens, J.R.**[1], Sims, N.A. [1], Vollbrecht, L. [1]

[1]Kampachi Farms LLC, Kailua-Kona, Hawai‘i

The Kona Coast represents an ideal location for offshore aquaculture research and development. This presentation will review current research activities, and future research plans and deployments by Kampachi Farms, based at the Natural Energy Laboratory of Hawai‘i.

Much of our company’s research is focused on developing alternative diets for kampachi (*Seriola rivoliana*), to reduce the reliance on marine-sourced proteins and oils, and to replace them with more sustainable, scalable feedstuffs. The company also continues research with other high-end so-called ‘carnivorous’ fish, such as mahimahi (*Coryphaena hippurus*), and Pacific Giant Grouper (*Epinephelus lanceolatus*). However, there has previously been very little research effort focused on aquaculture potential for high-end herbivorous fish. In Hawai‘i, a local reef herbivore, the nenue (rudderfish; a member of the Kyphosidae family), has always been prized as a food fish. These seaweed-grazers have a highly efficient ruminant-like hindgut, unique among marine herbivorous finfish, which allows them to digest and utilize macroalgae. Cultured nenue have the potential to be grown on a sustainable and economical diet including macroalgae, agricultural by-products and other plant-based materials. Our research focuses on feed trials and obtaining captive-spawns of wild-collected broodstock.

In partnership with Makai Ocean Engineering, Kampachi Farms is now beginning land-based trials to test various Hawaiian macroalgae for their potential use as food, feed (such as for the nenue) and in biofuel production. The long-term goal of the project is to conduct trials of an offshore seaweed array that might offer an opportunity to increase productivity and biodiversity, and generate renewable energy. Scale-up of macroalgae culture to commercial volumes will provide a carbon sink and may potentially have an impact on localized reduction of ocean acidification. We are planning a community outreach program over the coming year to discuss siting and impact mitigation.

**6 December, 4:00 PM**

**Revitalization of the Fishpond of Kīholo**

**Rebecca Most[1], Kuʻulei Keakealani[2]**, Chad Wiggins[1]

[1]The Nature Conservancy, Kailua-Kona, Hawai‘i
[2]Hui Aloha Kīholo, Kailua-Kona, Hawai‘i

Ka loko o Kīholo (Kīholo fishpond), located in the ahupua’a of Pu’uwa’awa’a, North Kona, Hawai’i, is a place where deep community connections support valuable ecological services, such as restoring habitat for native reef and estuarine flora and fauna. In 2012, The Nature Conservancy (TNC) facilitated a participatory Conservation Action Plan (CAP) to outline the stewardship and revitalization of Kīholo, which includes lineal descendent and kupuna knowledge, to ensure that conservation actions are perpetuating the generations of stewardship that have managed Ka Loko o Kīholo. The CAP incorporates multiple conservation strategies informed by adaptive traditional management to improve estuarine

habitat and provide a place for researchers, students, and community members to connect with nature and learn about estuaries and traditional fishpond management. The Hui Loko, a regional network of fishpond managers and practitioners has also played a vital role in the restoration of Kīholo fishpond. By collaborating with regional fishpond and anchialine pool managers, the revitalization project has maximized knowledge, labor and tools through collective efforts that bring together decades and generations of experience. Since restoration started in 2013, the ecological health of Kīholo's fishpond has improved thanks to 3,916 volunteers putting in 17,551 hours at 146 community work days hosted at Kīholo. Over 2 acres of invasive vegetation has been removed from the pond's edge and 800 linear feet of rock wall has been restored. With the support of community members, federal and state agencies, researchers, Hui Loko, and students, TNC has been monitoring Kīholo's fishpond ecology to determine whether revitalization efforts are effectively improving estuarine habitat, and to understand the important connections between the land and fishpond and between the fishpond and the adjacent coral reef ecosystem using a combination of scientific monitoring and traditional Hawaiian management and measurement techniques. We measure the process of our restoration goals by surveying riparian vegetation, sediment depth, water quality, and fish abundance and biomass. The stewardship for Kīholo fishpond has not only provided conservation benefits to native species, but also an opportunity to share knowledge throughout the community to perpetuate the traditions of this culturally, historically, and ecologically rich landscape.